MODIS Team Member -Semi-Annual Progress Report
Marine Optical Characterizations
June 1993

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NOAA/NESDIS

Significant progress has been made over this six-month reporting period. This progress has primarily been in the areas of rebuilding our at-sea experimental capabilities i.e. optical instrumentation, control and data acquisition software, mobile laboratories, radiometric calibrations, and operational procedures. Construction of a housing for the sky state video camera was completed. Maintenance and modifications to the old mobile laboratories were completed. Work was completed on the new thermoelectric coolers with circulating water heat exchangers for the Marine Optical System (MOS). A new filter set which approximates the SeaWiFS spectral bands were installed in the Hand Held Contrast Reduction Meter (HHCRM).

The completion of the Joint US-Mexico bio-optics cruise in the Gulf of California was the major activity during this period. The MOCE-2 experiment with the Mexicans provided a comprehensive set of bio-optical observations and served as a valuable opportunity to further test new instrumentation, measurement techniques, and operational integration of team personnel. The cruise ended on 14 April after completing thirteen bio-optical stations along the Pacific coast of Baja California and within the Gulf of California. A total of 2,900 n.miles of continuous trackline fluorescence, beam attenuation (531 rim), salinity, sea surface temperature and standard meteorological observations were collected (approximately 25MB of data per day). The station positions and tracklines are depicted in Figure 1.

The El Puma picked up the US and Mexican scientific personnel and equipment in San Diego, California, at the Scripps Marine Facility. A total of twenty-four US and Mexican scientist, technicians and students participated on the cruise. The Mexican team was lead by Prof. Saul Alvarez-Borrego. The US participants were:

NOAA/NESDIS - D, Clark and E. King
NASA/GSFC - S. Hooker and L. Rexrode (SeaWiFS Project)
Moss Landing Marine Laboratories - M. Yarbrough, M. Feinholz, Y. Kim, and N. Greene
San Diego State Univ. - C. Trees and D. Sullivan
Univ. of Miami -J. Brown

One unfortunate incident happened during the abandon ship drill, when Ed King suffered two broken ribs when he hit the water surface after jumping from a height of

approximately ten meters. He was sent back to Washington during the in-port at Mazatlan, Mexico.

CALIBRATION:

We (myself, M. Yarbrough, and M. Feinholz) participated in the SeaWiFS Calibration Round Robin held at San Diego State University, CHORS June 21-25. Our primary standards of spectral irradiance (two-FELs), a continuously variable integrating calibration sphere (Optronic Laboratories Inc. Model 420) for spectral radiance, two EG&G-Gamma Scientific portable reference lamps, reflectance plaque (Labsphere Inc. ,shunt, HP voltmeter, and a modified underwater diving light were run in the round robin. A report containing the preliminary results is available from James Mueller or Charles McClain.

The diving lamp system is of particular interest to our calibrations and monitoring of the MOBY system drifts during the three month deployment periods. The concept is to use divers and a stable light source to measure, in-situ, the system response at each fiberoptic collector periodically during the deployment period.

The battery powered lamp was operated continuously and monitored with the NIST PR714 every 2 to 4 minutes over a seventy-eight minute period at which time the battery was drained. Means and RMSE % of the spectral scans for forty-four measurements were computed at every 2 nm interval. The mean RMSE was 0.3%, maximum RSME was 1.3%, and the minimum RMSE was 0.06% indicating excellent stability for such a system. Improvements to the constant current monitoring electronics and further testing is planned. This approach may provide a very accurate technique for determining system changes due to bio-fouling.

INSTRUMENTATION DEVELOPMENT

During the June Calibration Round Robin we , C. Cromer and C. Johnson (NIST) met with EG&G-Gamma Scientific personnel to discuss the redesign of a spectral irradiance and radiance calibration system (Gamma 5000) which I used in the CZCS experiments. The system was built by them in the 1970's and later discontinued. The 5000 system was kinematic and relatively insensitive to ambient light, which is required for calibrating the eighteen meter MOBY system. They agreed to consider our requirements and provide us with drawings of the modifications and quotes.

Work continued on the Galai noise problem in the low concentration, small particle ranges. Galai Inc. has agreed to provide a new lens, updated processing boards, and software to correct the problems. A new laser tube may also be required.

Tests to characterize a probable second order problem in the Marine Optical System (MOS), were initiated and the preliminary results have confirmed the problem. The second order problem in the MOS, a dual spectrograph with a spectral beam splitter, became apparent in the long wavelength spectrograph while making measurements in very clear water. The long pass filter has not been used since the second order effect was never observed in the laboratory. The dichroic reflects at the greater than 98% level in the blue (400-500nm) but has several 5 -20% leaks in and around 380nm. In clear ocean waters at 350-400nm the surface intensity levels are two to four orders of magnitude higher than that at the 700-800nm range and will require the future use of the long pass filter in the red spectrographs optical train.

Plans for converting the Army surplus container into a mobile laboratory for at-sea deployment were completed (Figures 2a & 2b) and materials were ordered.

MARINE OPTICAL BUOY

The new Photometric detector heads and electronics were interfaced to an ISA spectrograph and initial testing of the systems was started.

Mooring Systems Inc. completed the deep ocean mooring design study and simulations. In all but one case the subsurface mooring configuration failed. Although this configuration could be viable with major increases in buoyancy the mooring cost increase would be prohibitive. A new surface, slack-line mooring design configuration has been selected and is now under construction.

SUPPORTING GRANTS AND INTERAGENCY ACTIONS:

The proposal for the San Jose State University - Moss Landing Marine Laboratory (MLML) phase three grant was submitted and the grant awarded during this period.

A total of $110 K from NOAA was transferred to GSFC, Charles McClain, to supplement the prototype modifications to MOBY and Hawaii operations.

PERSONNEL:

The candidate for the GS-11 oceanographer position was selected and final negotiations are now underway. Eric Stengel reported for work in April.

DATA:

The CZCS optical data base was transferred to the SeaWiFS Data Archive.

All of the MOCE-2 along-track one hertz data were processed through the time

registering and time averaging programs. In May the data were reviewed and a software error was found in the averaging program requiring complete reprocessing. All of the MOCE-1 and MOCE-2 along-track data were reprocessed. Reprocessing of the profiling data is fifty percent complete. An example of the MOCE-2 three minute averaged transmissometer and fluorometer data for a twenty-four hour period is shown in Figure 4.

Some other examples of the primary observations are illustrated in the following figures:

Figure 5. Spectral distributions (2-3nm resolution) of downwelled irradiance, upwelled radiance, and the incident irradiance as a function of depths for a MOCE-1 station off of Point Sur California. The data were acquired with the prototype dual spectrograph Marine Optical System (MOS) before water cooling was added. The data are abbreviated at 700nm due to second order effects and instrument self shading.

Figure 6. Spectral diffuse irradiance and radiance attenuation coefficients and the water-leaving radiance derived from the data in Figure 5.

Figure 7. Vertical profiles of the downwelled irradiance (Ed 486 rim), beam attenuation coefficient at 660 nm corrected for pure water ($C_p(m^{-1})$), In-vivo chlorophyll a fluorescence and the downwelled diffuse irradiance attenuation coefficient (K_d486nm). These data were acquired with the CHORS Biospherics Inc. Mer 2040 during the MOCE-1 cruise.

Figure 8. Illustrates the observations measured and derived from the MLML CTDO system. In addition to the standard conductivity, temperature, depth, and oxygen measurements, this system also measures fluorescence at 590 and 680nm and beam attenuation at 490nm over a folded meter path length.

SHIP TIME:

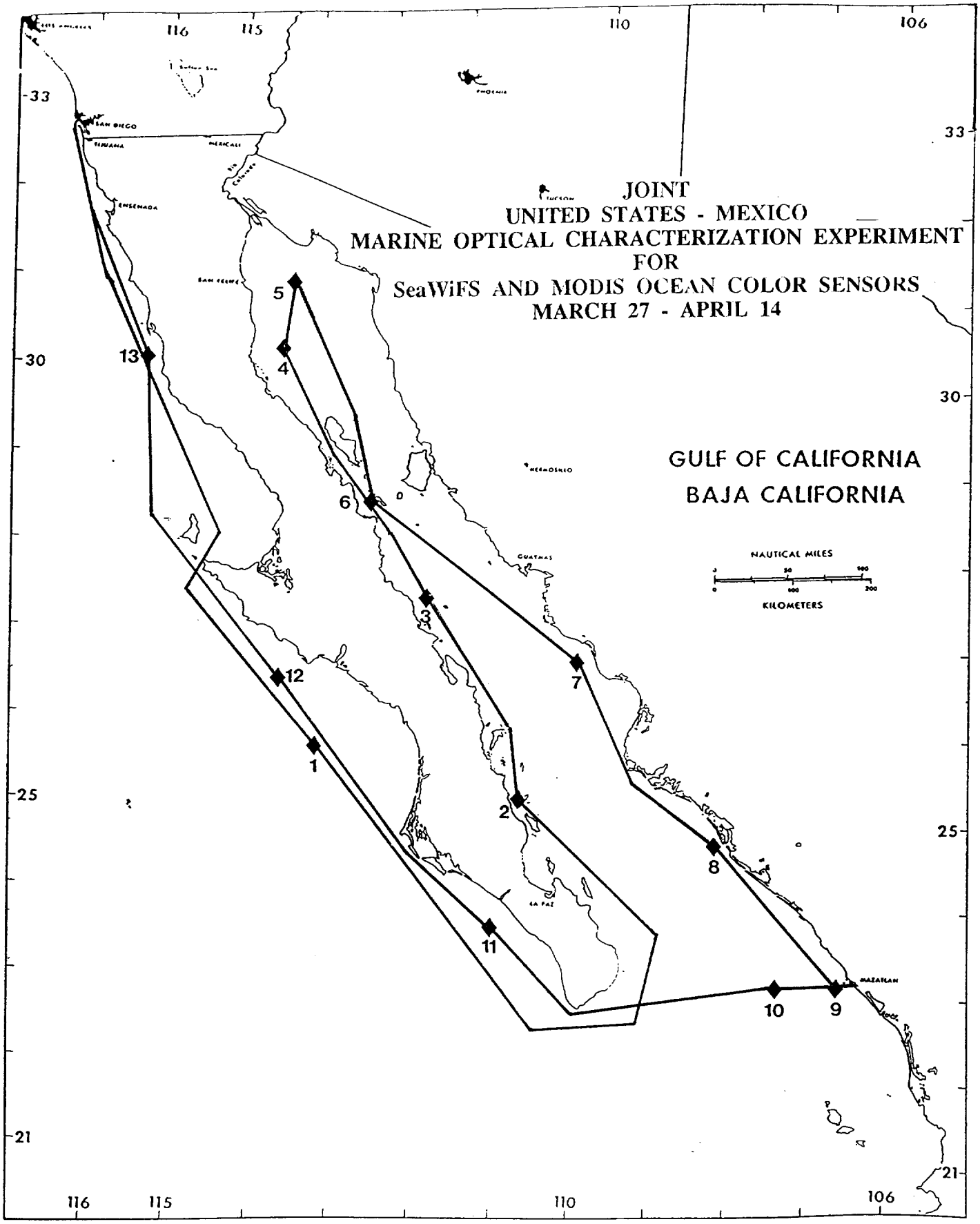
A critical element to this research is obtaining independent funding/access to research vessels for dedicated algorithm or validation cruises. Given our ship requirements, we must secure ships which are costing around $12K to $15K per day. This adds up to approximately $750K to $1,200K per year depending on the Calibration/Validation tasks.

Requests for NOAA ship time support for the Marine Optical Buoy (MOBY) operational support (mooring deployment and refurbishments) and one bio-optical algorithm

development cruise per year were requested for FY-93, FY-94, and FY-95. The request for FY-93 was denied and only twenty-two days of chartered (UNOLS) time was approved for FY-94. This time was for support of the MOBY operations in Hawaii during FY-94. The disposition of the FY-95 request is still under review.

The cooperative arrangement with Mexican Laboratory Centro de Investigation Cientifica Y EDUCATION Superior (CISCE), Ensenada, Mexico, appears to remain solid. The MOCE-2 cruise in the Gulf of California, in which the ship time was totally funded by the Mexicans, was very successful. We are tentatively planning to schedule thirty-five days on the RV El Puma in the fall/winter of 1994/95 to support the SeaWiFS initialization. This ship support could continue through the EOS MODIS launch. Additionally Dr. Octavio Limas Gonzalez, Director of Centro de Tecnologia Pesquera, Gran Canary Island, will provide ship time whenever we can afford the operational effort.

It should be noted that none of the foreign ship support is covered under any formal agreement. The status of ship time initially reported in March has remained unchanged with the exception that the NOAA MOBY support has been approved at the NOAA level.


JOINT
UNITED STATES - MEXICO
MARINE OPTICAL CHARACTERIZATION EXPERIMENT
FOR
SeaWiFS AND MODIS OCEAN COLOR SENSORS
MARCH 27 - APRIL 14
GULF OF CALIFORNIA
BAJA CALIFORNIA
NAUTICAL MILES
KILOMETERS
SAN DIEGO
TIJUANA
MEXICALI
ENSENADA
GUAYMAS
LA PAZ
MAZATLAN
116
115
110
106
33
30
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21
1
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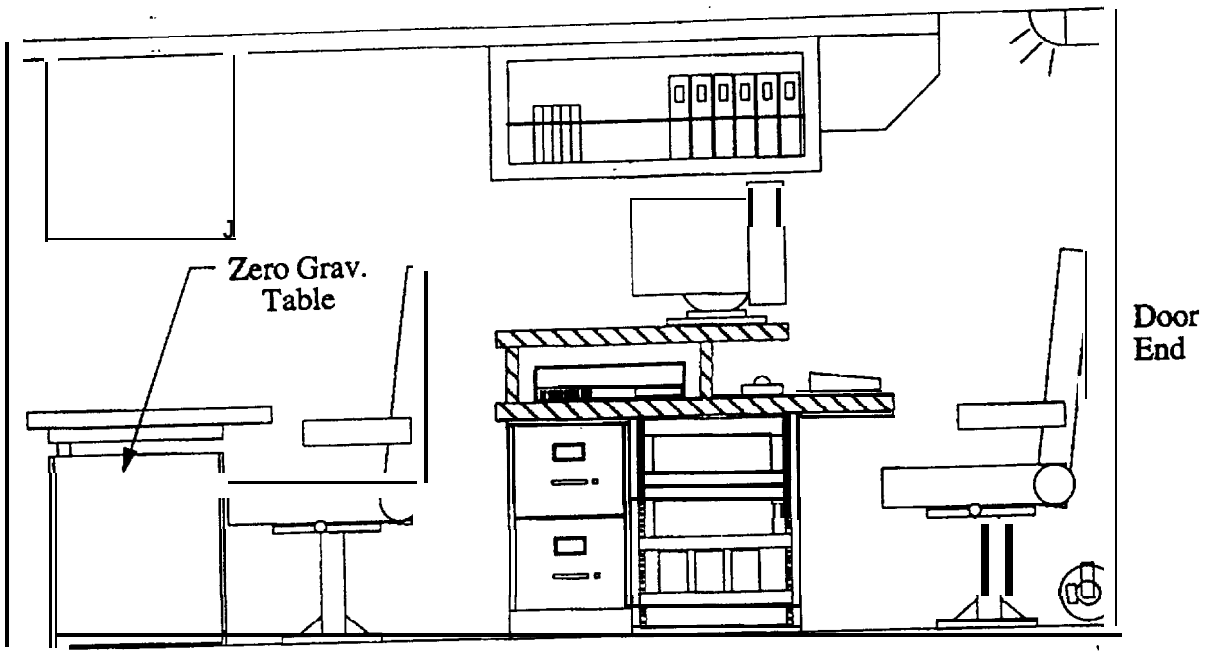
11
12
13

FIGURE 1.


Zero Grav.
Table
Door
End

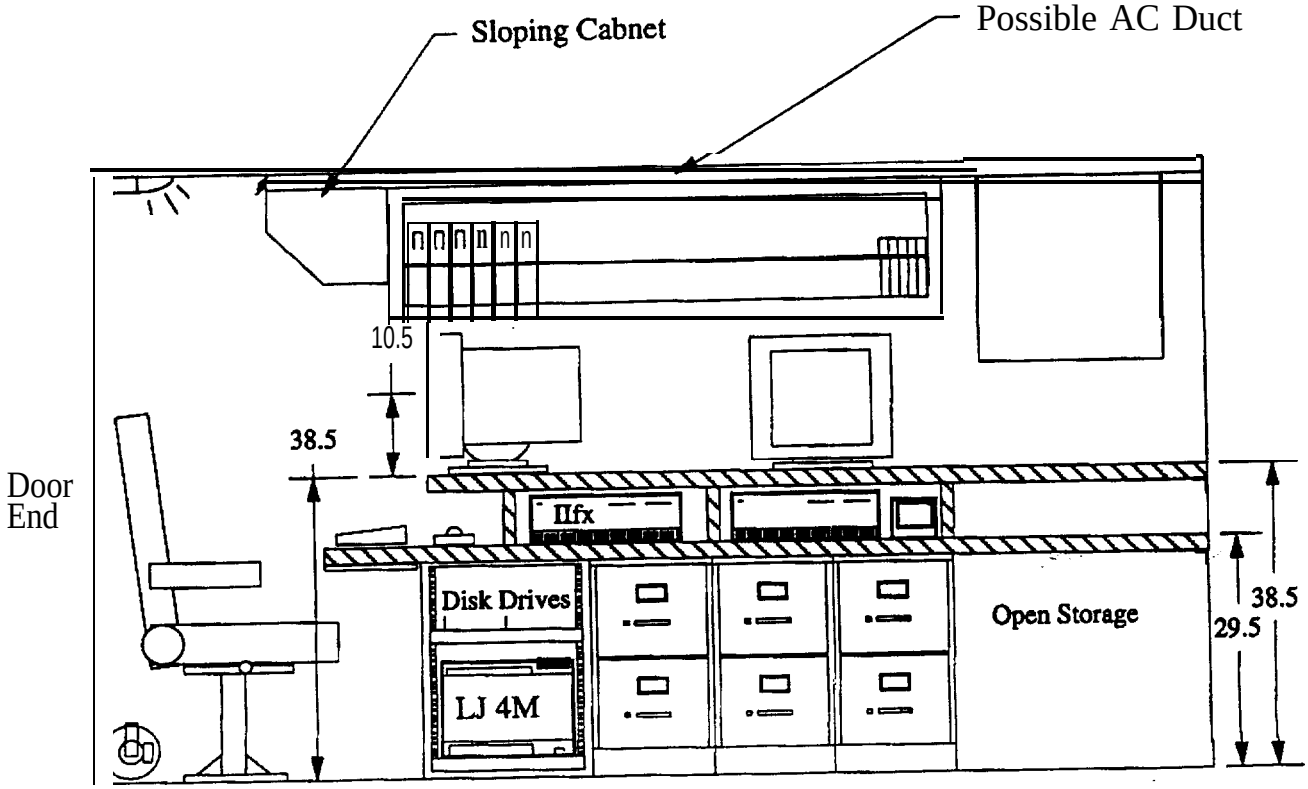

Sloping Cabnet
Possible AC Duct
10.5
38.5
Door
End
IIfx
Disk Drives
LJ 4M
Open Storage
38.5
29.5

FIGURE 2a.

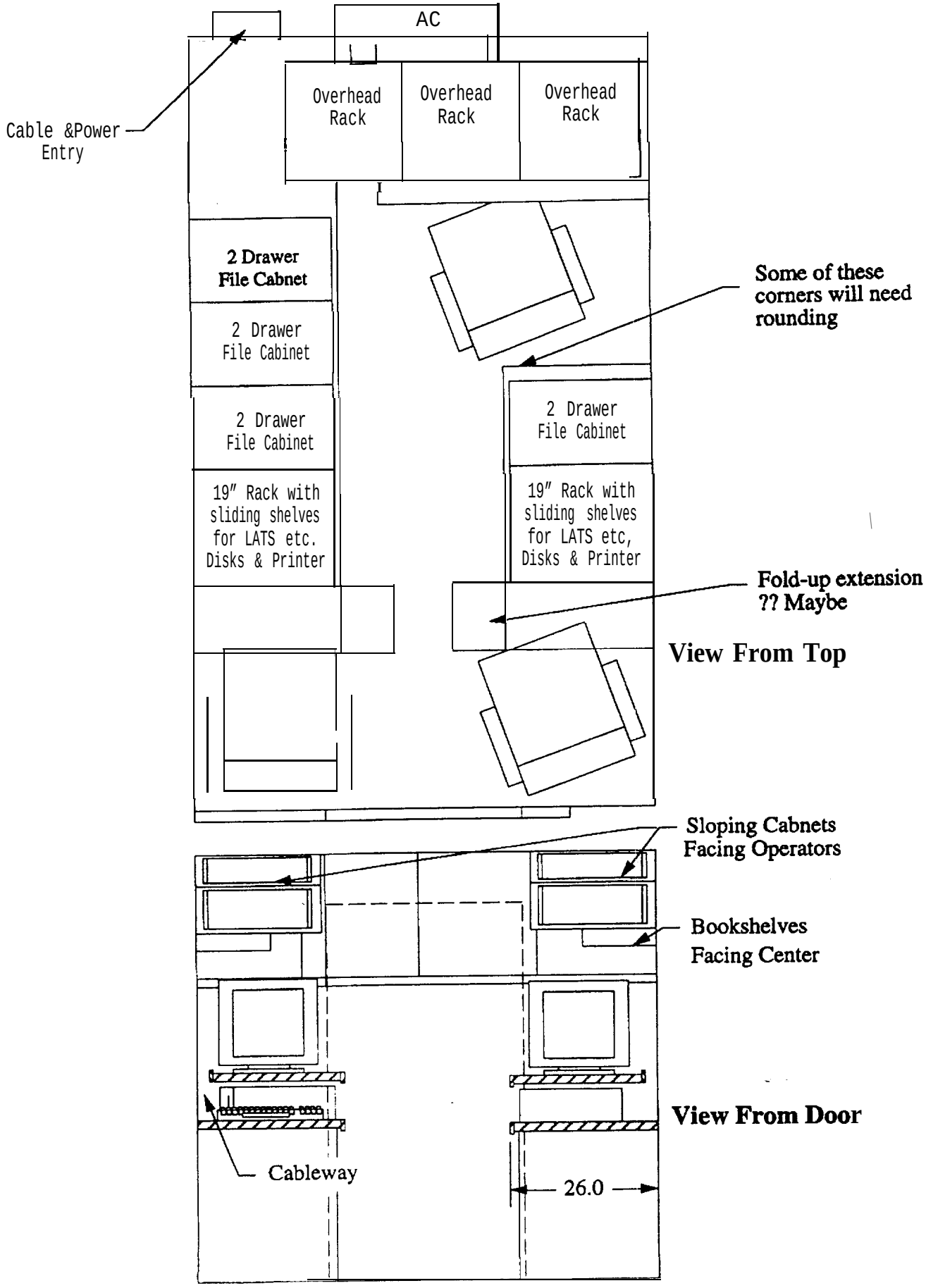
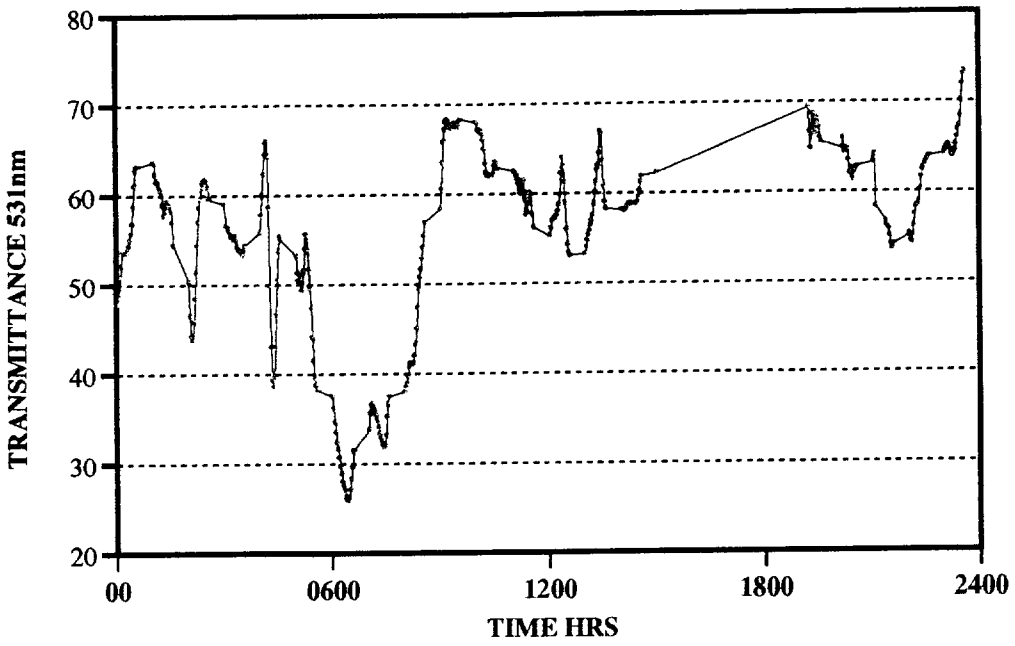

AC
Overhead Rack
Overhead Rack
Overhead Rack
Cable &Power Entry
2 Drawer File Cabnet
2 Drawer File Cabinet
2 Drawer File Cabinet
19″ Rack with sliding shelves for LATS etc. Disks & Printer
2 Drawer File Cabinet
19″ Rack with sliding shelves for LATS etc, Disks & Printer
Some of these corners will need rounding
Fold-up extension ?? Maybe
View From Top
Sloping Cabnets Facing Operators
Bookshelves Facing Center
Cableway
26.0
View From Door

FIGURE 2b.

MODIS Marine Optical Characterization Experiment - 2

CRUISE: MOCE-2 SHIP Puma
TRANSIT LEG # 6
POSITION: 30 º 88.8 N 114º 22.6 W to 28º 33.4 N 112º 58.5 W

WAVELENGTH: 531nm
DATE: 4 APR. 1993



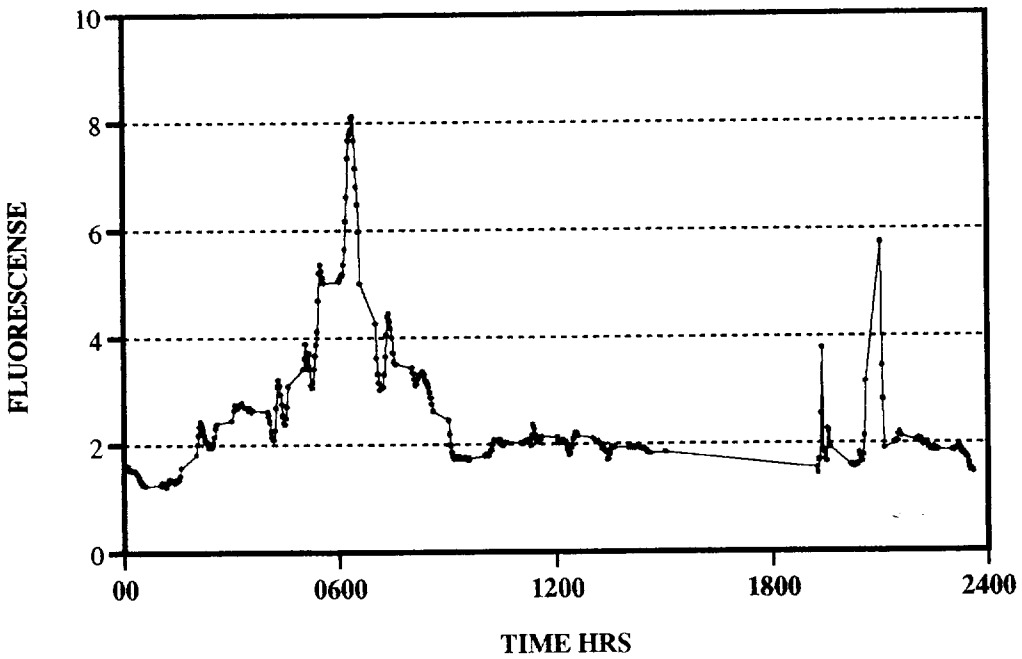


FIGURE 3.

MODIS Marine Optical Characterization Experiment - I NOAA/MLML

CRUISE: MOCE-1 SHIP: De Steiguer
STATION: 11 - Point Sur

Sfc = 2 m
Mid = 6 m
Deep = 11 m

POSITION: 36°12.9 N 121°48.0 W
DATE: 22:10 (GMT) 06 Sep 1992

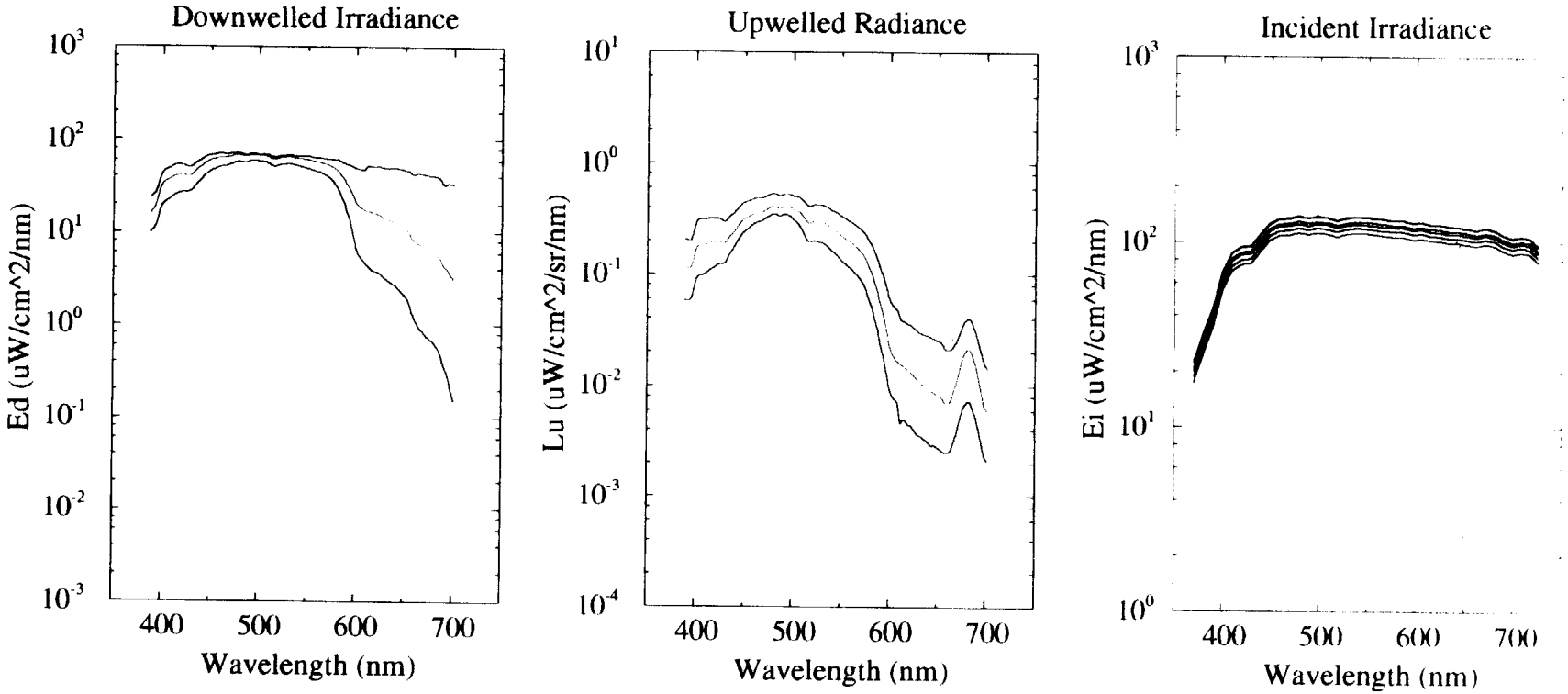


FIGURE 4.

Note: Not Corrected For Instrument Shading

MLML 12 Jul 93

MODIS Marine Optical Characterization Experiment - I NOAA/MLML

CRUISE: MOCE-1 SHIP: De Steiguer
STATION: 11 - Point Sur

Sfc = 2 to 6 m
Mid 2 to 11 m
Deep = 6 to 11 m

POSITION: 36°12.9 N 121°48.0 W
DATE: 22:10 (GMT) 06 Sep 1992

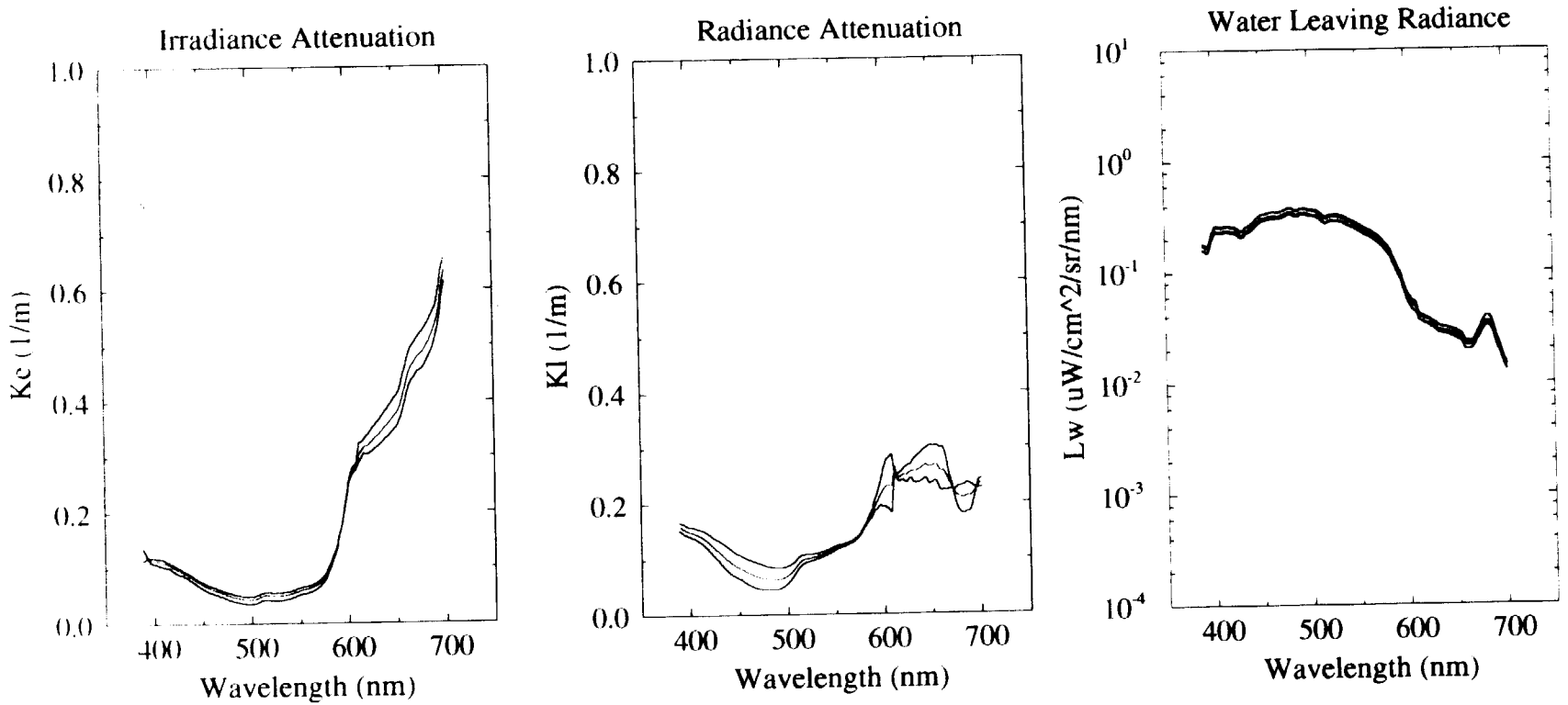


FIGURE 5.

Note: Not Corrected For Instrument Shading

MLML 12 Jul 93

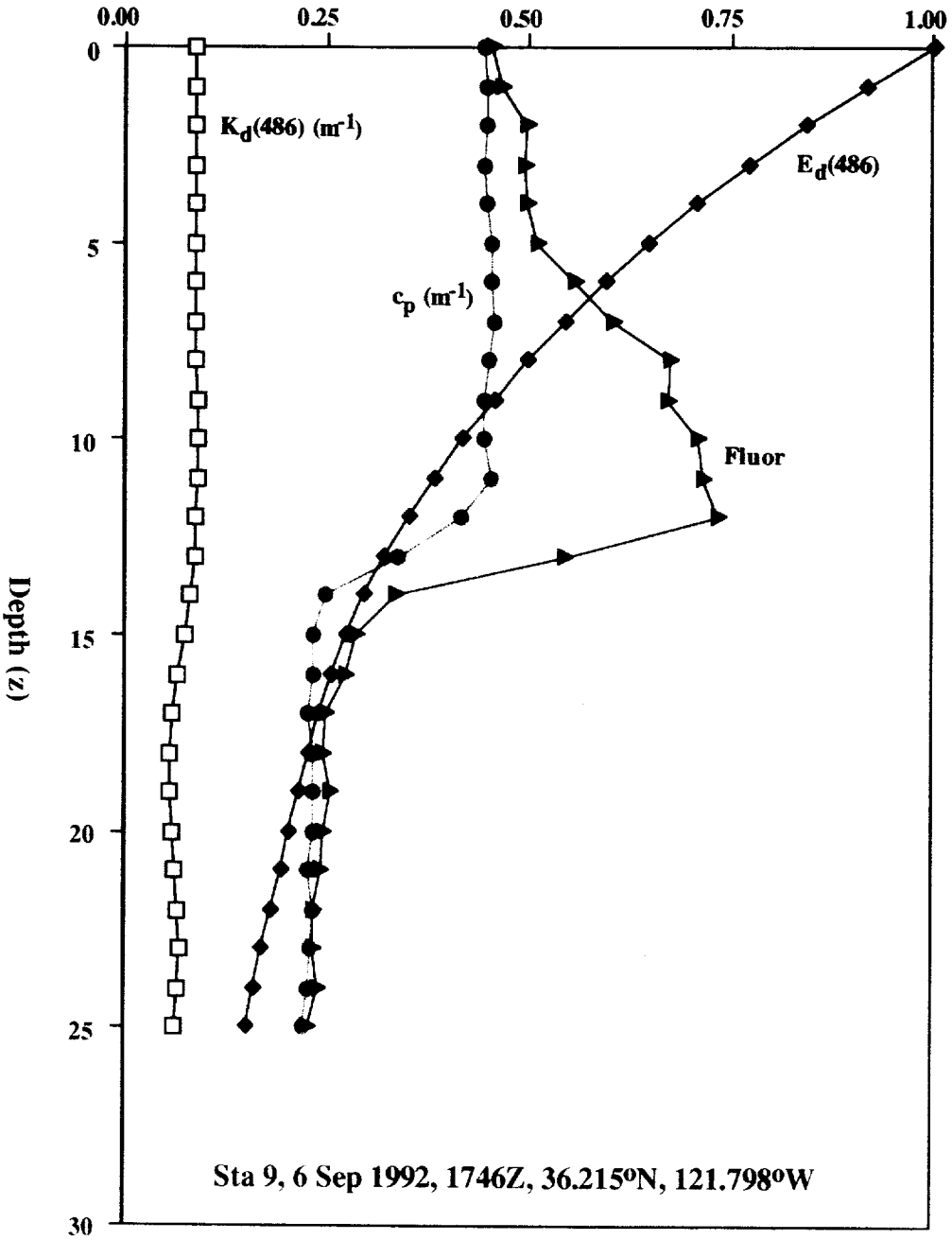

0.00
0.25
0.50
0.75
1.00
0
5
10
15
20
25
30
Depth (z)
$K_d(486)$ (m^{-1})
$E_d(486)$
c_p (m^{-1})
Fluor
Sta 9, 6 Sep 1992, 1746Z, 36.215°N, 121.798°W

FIGURE 6.

CRUISE: MOCE-1 SHIP: De Steiguer
STATION: 11- Point Sur
DATE: 21:42 (GMT) 06 Sep 1992
POSITION: 36° 12.9 N 121° 47.9 W

CTD # 5034
Wind 15 kts; Waves 4 ft; Sky clear
Secchi: 12.5 m Munsell: 10G 7/6

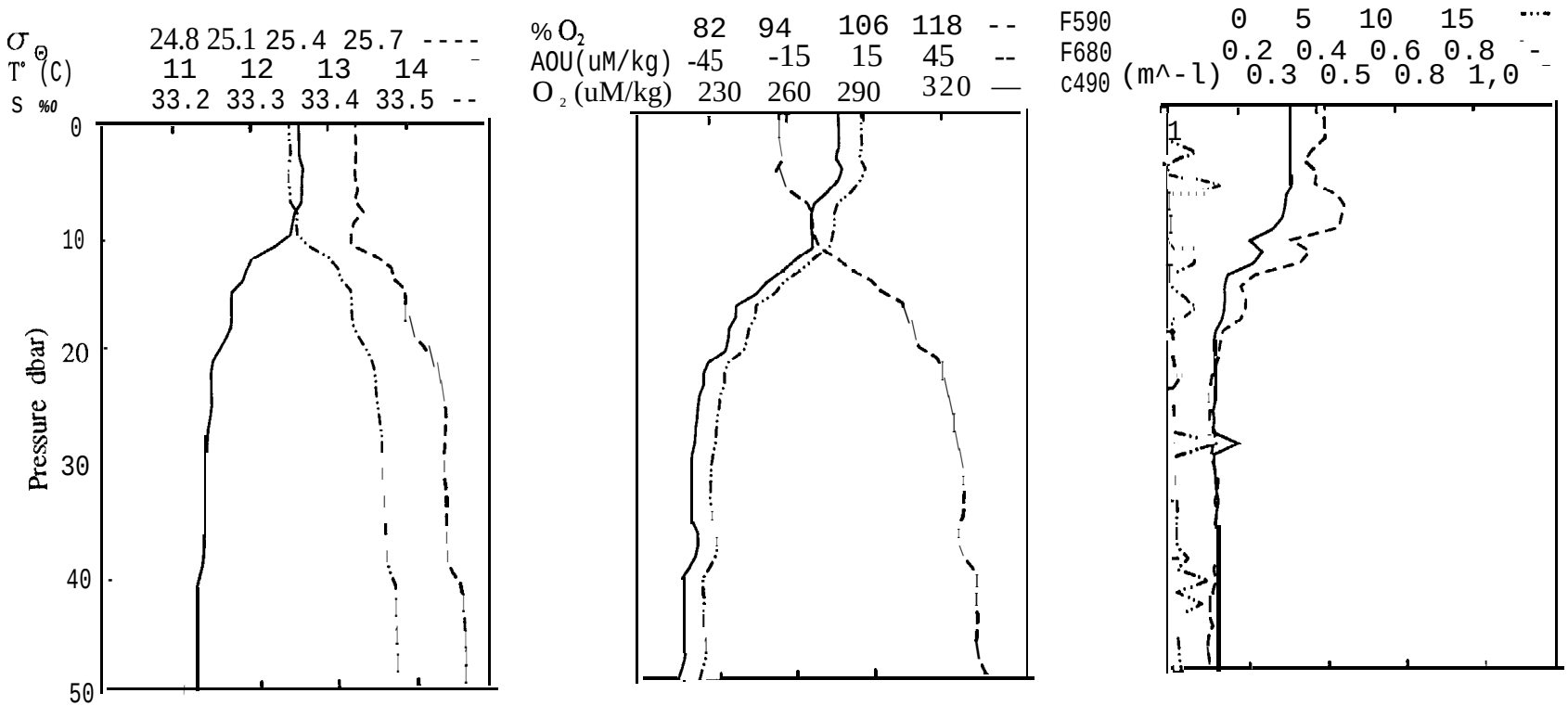


FIGURE 7.